

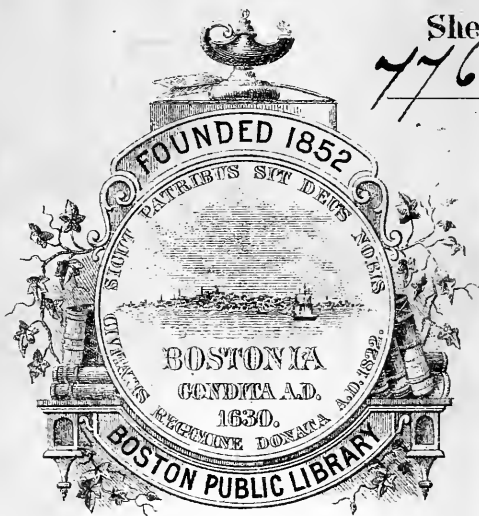


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OBSERVATIONS

ON THE

Harveian Doctrine

OF THE

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CIRCULATION OF THE BLOOD.

BY GEORGE KERR.

Ζήλω γὰρ τὴν Ἀληθεῖαν ὕφ' ἧς εὐδεις πάποτε ἐβλάβη.

Marcus Antoninus.

Ἡ δὲ πειρὰ σφαλέρη.

Hippocrates.

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June 20, 1852

D. CHALMERS & Co. Printers,
Aberdeen.

TO
JOHN ABERNETHY, ESQ. F.R.S.

&c. &c. &c.

PROFESSOR OF ANATOMY AND SURGERY

TO THE

ROYAL COLLEGE OF SURGEONS, LONDON.

Dear Sir,

ALTHOUGH I do myself the honour of addressing the following observations to you, it becomes my first duty to state that I have no right to assume any assent, on your part, to the heretical opinions they contain. It may, however, procure them a patient perusal by some, who, firm believers in Harvey's doctrines, might otherwise deem them unworthy of notice, to mention that a part
a of

of the manuscript was, for some time, in your hands, and that you candidly admit the *possibility* that the Harveian hypothesis may be unfounded. You say men form their own minds by repeatedly thinking in a particular manner, nor can any sudden change of their opinions be expected—that it is difficult to say who is in the right in this case, and all may be wrong—that were my observations published, some would consider them as ingenious, but they would produce no change in their opinions, while others, whose opinions were less inveterate, might be convinced by them, and think as I do. At any rate, they would excite investigation. At the same time you said, that, in your opinion, the Harveian doctrines could only be successfully combated by experiment, and that you would not publish any opinions that were not deductions from facts. Now I believe that I have stated facts for the most part acknowledged by all, and, to the best of my information, have

have drawn fair inferences. I have not tried experiments, because I conceive that we have facts and experiments, reported by men of high authority, abundantly sufficient to enable us to ascertain the truth; and I can with more confidence appeal to these than I could report what I had myself ascertained, because my reports might have been suspected of partiality, or inaccuracy.

In my opinion, Harvey reasoned falsely from the experiments he made, and, having persuaded himself that the pulse is occasioned by the distension of the left ventricle, by the blood exciting it to contraction, he assumed the connexion of extreme arteries with veins, and the circulation through the lungs, as necessary consequences of the first assumed fact. Some years have now elapsed since I began to entertain doubts of the truth of this hypothesis—for eighteen months past the subject has engaged much of my attention—and I can honestly declare, that the more I have studied the

works of Harvey, Walæus, Pitcairn, and others, who maintain the doctrine, the more firmly am I convinced that it is altogether untenable. My objections I have stated to many of my medical friends, some of whom agree with me in thinking them insuperable—some abide by Harvey's doctrine, but say nothing pointed against the facts I have stated, contenting themselves with the repetition of assumptions and conjectures as to how the circulation *must* be carried on—and a great majority tell me that they never suspected any fallacy in the generally received opinions, and that they remain in doubt. It is, however, a question which every man of liberal education may enter upon, and decide for himself; and I cannot help thinking that our profession would have been, at the present day, more respectable, had the attention of literary men been more closely directed to our proceedings; for, as we neither have secrets, nor pretend to magic, quackery could

could not have prevailed so much, had it not been for the negligence and consequent ignorance of those who ought, in some measure, to have been our censors.

The medical men retired from practice, and scholars, not of the profession to whom I have shewn my observations, are nearly unanimous in assuring me that they believe them well founded; but in many of my professional brethren there has appeared a great reluctance to enter upon the discussion, amounting to a seeming dread of conviction. Indeed, in many cases, it might be a serious affair for a practitioner to declare himself a schismatic from the Catholic physiological persuasion; and I continue to urge the subject upon your attention, because if, after reflection and due investigation, you find reason to depart from what you call the faith in which you were educated, I shall expect your ready and full recantation. For, in the words of Celsus,

I can assure you that thus you will act—
“ More scilicet magnorum virorum, et fiduciam magnarum rerum habentium. Nam levia ingenia quia nihil habent, nihil sibi detrahunt; magno ingenio multaque nihilominus habituro, convenit etiam simplex veri erroris confessio.” But your remark concerning the difficulty of effecting any change in the public opinion is unquestionably just, and all I propose by printing the observations in their present state is to call the attention of professional men to the subject. By patient and impartial investigation, the truth may be ascertained, and by fair reasoning from established facts, we certainly ought to arrive at complete and full conviction of what, in this case, the truth really is. You will admit that, since the time of Harvey, our physiology has been almost as changeable as the cut of our clothes; and Dr. William Hunter used to say that no Physiologist could leave a reputation behind him that would outlive him
half

half a century. “When they cease from their labours,” (said he,) “their labours will be buried along with them. There never was a man more followed and admired in physiology than Boerhaave. I remember the veneration in which he was held; and now, in the space of forty years, his physiology is—it shocks me to think of the light in which it appears.” This instability of physiological and medical theory may, I think, be fairly traced to the doctrine of Harvey, for, although, before his time, Physiologists differed in some points, in the great outlines they were perfectly agreed.

The antient Physiologists believed the vital spirit of man to be something ætherial, and of a superior order to mere matter perceptible by our senses. Harvey, who reduces man to a hydraulic machine, laughs at the idea of any thing more divine than the blood in the composition of man; and
 very

very positively denies the existence of vital spirits because he had never seen them.* He argues that these vital spirits must necessarily be colder than the blood, because they are said to be derived from air and vapour—a notion which it is unnecessary seriously to refute at the present day ; and, upon the whole, his ideas of the animal economy he declares to be bounded by objects of sense. From this doctrine many, of late years, have been led to derive materialism, and the extinction of the soul by death ; while, on the other hand, the antient Physiologists believed and taught that the soul is immortal, being in its nature indestructible, and that it must necessarily survive the body.

Hippocrates

* Nos neque in venis, nervis, arteriis, aut partibus vivorum dissectionibus explorando invenimus.

Hippocrates, in the beginning of one of his books, says, that “although it is not the province of a Physician to speak of divine essences, unless in so far as they are connected with the nature of man, it is yet necessary for him to lay down some general principle from which he may reason.” Therefore, says he, it appears to me that what we call *animal heat* is immortal—comprehending hearing, seeing, and perceiving, all things present and to come.* In one sense it may be that every material form is indestructible, and that Ovid’s “*nihil interit cuncta mutantur*” is literally true; but the ancients believed the soul of man to be *divinæ particula auræ*, not subject to the laws of organized matter, and that its happiness or misery in another state would

* Δοκει δὲ μοι ὁ καλεσμεν Θερμον, ἀθάνατον τ' εἶναι καὶ νοεῖν πάντα καὶ οἰεῖν καὶ ἀκχεῖν, καὶ εἰδέναι πάντα, καὶ τὰ οὐρα, καὶ τὰ μελλόντα εἰσεσθαι.

would be influenced by the deeds done in the body. Whatever difference of opinion may exist concerning the intelligent principle in man, and its mode of existence, all appear now persuaded that an invisible, active, and powerful agent pervades all nature, not subject to our sublunary laws of motion, but passing through extended space with the rapidity of thought. That this agent is, in some manner to me unknown, the prime mover in the human body, and that from it all animal motions, voluntary as well as involuntary, proceed, is, I think, probable in the highest degree, and that the motion of the heart, and pulsation of the arteries, are to be accounted for in a manner of which Harvey had not the most distant idea.

The experiments made by Sir Humphry Davy, who has analysed many substances, long, but erroneously, termed simple, convince me that no really simple substance
can

can be comprehended by our senses. If all terrestrial substances have not yet been analysed, and reduced to that state in which they elude our view, and escape into the atmosphere, that affords no convincing proof that there are bodies in nature unsusceptible of such analysis; as it is no proof that undiscovered countries are inaccessible, because no navigator or traveller has yet approached them. The essence of all matter philosophers hold to be one and the same, and that what is susceptible of decomposition may again, by synthesis, acquire new form, and this is exactly what was taught by Pythagoras, and is, in fact, the philosophy of Moses.—Such also was the opinion of Sir Isaac Newton, who says, “Are not gross bodies, and *light*, (or æther,) convertible into one another, and may not bodies receive much of their activity from the particles of light, which enter into their composition? The changing of bodies into light, and light into bodies, is very agreeable

able to the course of nature, which seems delighted with permutations. Water, which is a very fluid tasteless salt, she changes, by heat, into vapour, a sort of air—and by cold into ice, which is a hard pellucid, brittle, fusible stone; and this stone returns into water by heat, and vapour returns into water by cold. Earth, by heat, becomes fire, and by cold returns into earth.” He proceeds to give many other instances of transmutations, and, upon the whole, appears to adopt the Pythagorean doctrine, so beautifully expressed by Ovid—

“ *Resolutaque Tellus*
In liquidas rorescit aquas: tenuatas in auras
Aëraque humor abit; dempto quoque pondere rursus,
In superos aër tenuissimus emicat Ignes.
Inde retro redeunt: idemque retexitur ordo.
Ignis enim densus, spissatus, in aëra transit,
Hic in aquas: tellus glomerata, cogitur unda.
Nec species sua, cuique manet: rerumque novatrix
Ex aliis alias, reparat Natura Figuras.”

According

According to this philosophy, the Mosaic account of the creation presents nothing incompatible with the principles of just reasoning, and the expressions of scripture, that *we are his offspring*,* and that in our Creator we live, move, and have our being, convey nearly the same meaning as the following beautiful lines from the “Interpres Sacer Deorum”—Orpheus.

Zeus παῖς γενέτο, Zeus ὑψάλῳ ἀρχικεραυνῷ
 Zeus κεφαλῇ—Zeus μεσσα—Λίος δ' ἐκ πάντα τέτυκται
 Zeus πυθμην γαίης, τε καὶ ἕραν αἰθεροενίος.
 Zeus ἀρσὴν γενέτο, Zeus ἀμβροτός ἐπ' ἑλίο νυμφῇ,
 Zeus πνοή παύλων, Zeus ἀκαμάει πυρὶ ὄρμη.
 Zeus πονίῃ ῥίζα—Zeus ἥλιος ἦδε σελήνη
 Ζεὺς βασιλεὺς, Zeus ἀρχοὶ ἀπάντων ἀρχικεραυνός.
 Πάντας γὰρ κρυψας, αὐδὴς φάος ἐν πολυγυῖτις
 Εἰς ἱερῆς κραδίας ἀνενεγκάλο μέγμεγα ρέζων.

b

The

* Τῶ γὰρ γενεῶμεν.—The words of the Poet Aratus, quoted, with approbation, by St. Paul, in his Address to the Athenians.

The same sentiment occurs frequently in the writings of the antient Poets and Philosophers; and among the Romans, such expressions as “Jupiter est quodcunque vides”—“Jovis omnia plena”—shew that they entertained the same philosophical principles with the ancient Greeks.

With regard to man, they entertained very elevated notions of his origin, susceptibility of improvement, and the future state of the good after death. They did not believe, as some materialists affect to believe, in a “*principle of intelligence*,” that may be purged, vomited, and sweated—dispersed by evacuations, and renewed by beef and pudding, turtle, port, and porter;* nor did they believe, because the soul of man is not, *per se*, comprehensible by our senses, that it has, therefore, no existence. “Bury me” (says Socrates to a friend) “as
you

* Monthly Review of M. Tralle’s Work concerning the immaterial Soul.

you please, provided you can catch me, but it seems I cannot convince you, that, when my dead body lies before you, the Socrates, who now addresses you, and reasons with you, will be no longer present." The address of Cyrus to his friends, as given by Xenophon, expresses very beautifully the same sentiment, the same conviction of the immortality of the soul, and that all the parts of the body are merely its instruments. The Physicians of antiquity attended particularly, in every case, to the state of the patient's mind, and some very striking instances of their sagacity are upon record, in discovering that disease had originated in affections of the mind. On the other hand, they knew that a diseased body may disorder, impede, or altogether suspend, the operations of the mind—that intemperance debases man, and prevents the free exercise of the reasoning faculty,*

b. 2

presenting

* Quin corpus onustum

Hesternis vitiis, *animum* quoque prægravat una

Atque affigit humo *divinam particulam auræ*.

presenting an insurmountable obstacle to that improvement which ought to prepare the soul for a more perfect and dignified state of existence. This physiology Harvey ridicules as the conjectures of ignorance, telling us that the blood is the true vital principle of the human body, as he had never discovered any thing more divine in his dissections; and inferring the non-existence of whatever is not perceptible by the human eyes. Let it not be said that *time* has confirmed the Harveian doctrine. It has prevailed for nearly two hundred years, but the erroneous doctrines of Ptolemy, concerning the system of the universe, prevailed for a much longer time; and the antient doctrine of Pythagoras, so long ridiculed by the ignorant as repugnant to the common sense of mankind, was received as a new discovery. The human mind is not always progressive in knowledge; we have dark ages, in which error prevails, and the most absurd speculations are

are received as founded in truth. In our profession it has become fashionable to speak with contempt of the *trammels* of antiquity, as imposing fetters on original genius; and the consequence is, that hypotheses, wild and extravagant, spring up and perish, with inconceivable rapidity, and in endless succession. An extension of the same principle would rid us of the trammels of education, that we might witness the sublime efforts of the human mind, unbiassed and unprejudiced. Is it not singular that medical men only should have to complain of restraints imposed upon their exuberant genius by the precepts of antiquity, (from which, indeed, they have very effectually disengaged themselves,) and, after innumerable failures, should still persist in believing that truth is to be ascertained by conjecture? The first orators of our times formed themselves upon the models of antiquity—I give, as instances, Chatham, Mansfield, and Fox. Robertson was ac-

b 3

customed

customed to animate the zeal of the scholars of the Edinburgh High School, by assuring them, that whatever credit he had acquired as a historian, he owed to a careful study of the antients—Euclid maintains his superiority as a mathematician—Archimedes as eminently skilled in the mechanic powers—we find Canova and Flaxman eagerly expressing their admiration of the unrivalled excellence of the works of Phidias. In poetry, sculpture, architecture—in every thing, we admit their superiority, (as I have elsewhere observed,) with the exception of medical science, including Physiology, and *Scotch Metaphysics*; for my countrymen declare that they have, of late, very much improved upon Aristotle.*

The

* In his Preface to a Dissertation on the Gout, Sir Richard Blackmore, one of the Heroes of the Dunciad, and Scriblerus, very coolly gives his reader this reference:—“*But if the reader is desirous to see Aristotle’s Philosophy fully displayed and confuted, I refer him to the 5th Book of my Poem, entitled Creation.*”

The medical authors of antiquity we hold convicted of neglect, nay even of folly, upon the authority of a man whose writings bear evidence that he was unacquainted with theirs, who, from appearances obvious to the meanest capacity, infers gross ignorance in the most learned men of the most learned ages.

Before I conclude I must notice an observation in one of your letters on this subject, viz. :—" That you are satisfied that I, who have so ingeniously discovered such strong objections to the Harveian doctrine, could, you are persuaded, have found many stronger ones to that of Erasistratus." As yet, the physiology of the antient Physicians is but a new study with me ; but, in as far as I have proceeded, I do assure you that I think it much more rational than our own, and, in particular, I have seen nothing in the doctrines of Erasistratus, as they are preserved by Galen, which, to me, appears contradictory.

contradictory. As to genius, or discovery, I have no claim ; the objections to the Harveian hypothesis arose spontaneously, without effort on my part, and the present rude sketch is evidently not the production of deliberate study. The notes, as they were originally written, are here printed—with inaccuracies and want of arrangement very obvious ; and the only apology I have to offer to you, and the public, is, that I send the present publication abroad merely as a *prodromus* of something, in a more finished form, which I hope will better deserve the public attention. My object in putting the notes, in manuscript, into the hands of professional men was, to know whether I had mis-stated any fact, or drawn unfair conclusions from the facts adduced, and that object I did not attain. I believe myself pretty well fortified by respectable authorities, but I shall gladly receive corrections as to facts and reasoning ; I shall only observe, that, as mere assumptions prove nothing,

nothing, and may be multiplied *ad infinitum*, I consider them unworthy of serious discussion.

I make no apology for numerous quotations, for I think them applicable ; and the original words of an author convey his sense in the clearest manner. I wish to have the opinions of those to whom the authors I have quoted are well known, and their language familiar ; and it can do students no harm to send them to consult their dictionaries. Quintilian says, that, in his times, there were some who considered “ *id pulchrum quod interpretandum sit*”—because they then enjoyed a pleasure “ *non uti legerint vel audivorint sed quasi inve-*
nerint.”

I have the honour always to remain,

With great esteem,

DEAR SIR,

Your's, very sincerely,

GEORGE KERR.

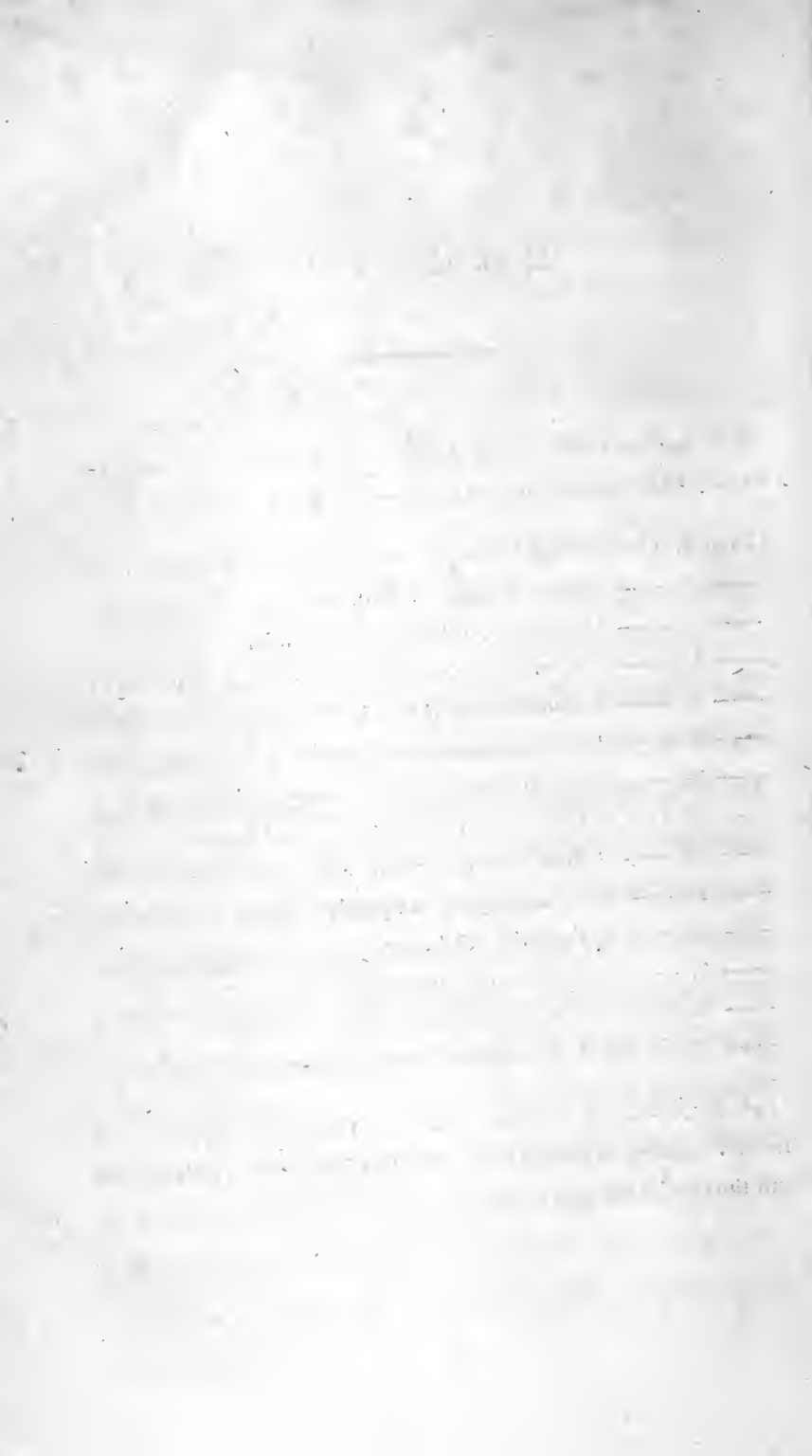
Aberdeen, June 8, 1816.

ERRATA.

It is requested that, before this Tract is read, the following Errata may be corrected with the pen :—

- Page 8, Line 5 from bottom, *for* Pitagorici, *read* Pitagorico
— 9 — 3 from bottom, *for* heat, *read* beat
— 16 — last line, *for* callular, *read* cellular
— 17 — 3 from bottom, *for* Phisiologist, *read* Physiologist
— 22 — 4 from bottom, *dele* it is
— 30 — 11, *for* batlement, *read* battement
— 30 — 14, *for* sixienne, *read* sixieme—*for* ligue, *read* ligne
— 33 — 8 from bottom, *for* arterers, *read* arteres
— 33 — 6 from bottom, *for* suit, *read* suite
— 44 — 9, *for* equally, *read* equably
— 46 — 8, *for* sang, *read* rang
— 47 — 2, *dele* comma after obstinacy
— 76 Note, l. 5, *for* expuriouse, *read* ex puriore
— 77 Note, l. 1, *for* paritem, *read* parietem—*for* et, *read* ut.

* * * P. 24.—From careless expression it might be supposed that the small arteries, extended to the shoulder joint, were really sent off from the subclavian, or axillary.



OBSERVATIONS,

&c.

IT has often appeared to me very extraordinary, that while we admit the superiority of the antients in poetry, history, oratory, mathematics, and hold as models their architecture, statuary, engravings, and all works of art that have been preserved to our times, we should yet consider their Medical and Chirurgical Works as unworthy of our regard—although we have the most unquestionable proofs, that many of the physicians of antiquity were men of the first talents, and these talents improved by unwearied attention to professional studies.

Certain it is, that of late years a notion has generally prevailed, that the medical men of the present times are possessed of all the knowledge of antiquity, to which they are daily superadding great and valuable improvements, so that the profession is now entitled to rank higher than at any former period. The antient writers are very nearly forgotten, or mentioned with a sort of pity bordering upon contempt, whenever a lecturer is about to apprise his pupils of their good fortune in coming into the world during the present enlightened age. In the meantime, one very strong circumstance passes unnoticed, viz.—that, upon careful comparison, we find that, with all our advantages, very few practical improvements have been made; and that the antient physicians, and even surgeons, cured diseases, and remedied accidents, much as we do at present, or by approved means which we *have allowed to fall into desuetude.*

The invention of the ligature, in repressing hæmorrhage from arteries, has been frequently attributed to Ambrose Pace; whereas it is most particularly described by Archigenes and Heliodorus, two of the most antient writers on surgery; and the cure of aneurism by double ligature is exactly described by Paulus Ægineta.

It is commonly repeated, that the ancients were ignorant of the distinction between arteries and veins; that they frequently confounded both with nerves; and, upon the whole, they are represented as altogether deficient in anatomical and physiological knowledge, because they say nothing distinctly concerning the circulation of the blood. It is, however, certain, that they perfectly knew the distinction between arteries and veins; and that, through a wounded artery, the whole blood of the body, or nearly so, might be evacuated: but they believed the blood to be, generally

speaking,

speaking, contained in the veins, a very small quantity, diffused in a subtile vapour, being naturally to be found in the arteries. Such was the opinion of Galen; but an older physician of great name, Erasistratus, maintained that blood is not naturally present in the arteries, but by diseases or wounds may be derived into them; and, although his writings are lost, the account of his tenets, given by Galen, while he attempts to refute them, is so complete, that we can form a very clear idea of the dispute at the present day.

The opinion of Erasistratus was, that the vital spirits, collected by the lungs from the atmosphere, were delivered to the heart, and by it transmitted through the whole arterial system. He believed, that when arteries are wounded the vital spirits escape, and the blood passes into the left side of the heart to supply the place; that the extreme branches of arteries and veins do
not

not inosculate; and that fever, or partial inflammation, according to circumstances, are the consequences of the presence of blood in the arterial system.

To this doctrine Galen objected: first, that there was no proof of the escape of animal spirits from a wounded artery, because we never see them so escaping; and, secondly, that, according to the idea of Erasistratus, the whole animal spirits must be exhausted before the blood can come to supply their place, and this we know to be inconsistent with the fact. As Erasistratus was long dead before Galen wrote, and his followers, having fallen into some errors in practice, had fallen into disrepute,* we can

B 3 only

* It has been asserted, that Erasistratus generally condemned blood-letting, because he believed that abstinence, fresh air, and cold water, would in every case render it unnecessary to men living temperately. In other words, he is said to have been a Pythagorean as

only conjecture what reply he would have made, had he been alive, to the objections of his antagonist.

But the subject is now as open to investigation as it was in the time of Galen; and, although the writings of Harvey have long been

to medical practice, trusting every thing, as Lewis Cornaro did, to temperance, and a well regulated life.

La preferenza poi che la medicina de Pitagorici dava al regolamento del vitto sopra tutti gli altri rimedi, fa molto stimare la loro sagacità, a chiunque sa con quante tediose esperienze s' arriva al fine a QUELLA NOBILE INCREDULITA SULLA VIRTU DELLE DROGHE, CHE SUOL DISTINGUERE ALCUNI POCCHI MEDICI DA MOLTI E VULGARI.—Such is the praise bestowed upon the Pythagorean practice by a very learned physician of the last century :

Cocchi, del Vitto Pitagorici.

The same author informs us, that Pythagoras reckoned THREE fluids in the human body ; that he distinguished them “ secondo la differenza della loro densità, sangue, acqua, o siero, o linfa, e vapore.”

been supposed to have decided the question against both, but more pointedly against Erasistratus, there are yet difficulties attending the Harveian hypothesis of no easy solution.

Two facts are chiefly depended upon for the establishment of the Harveian hypothesis:—1. That the arteries, when wounded, never fail to pour out blood ; and, 2. That the valves of the veins seem so disposed, as to facilitate the passage of venous blood towards the heart, and prevent its reflux towards the extremities. The systole he attributes to the contractile power of the left ventricle, when distended with blood ; and the pulse to the rapidly transmitted *unda* of blood pervading the arterial system. He admits, that the motion of arteries occasioned by the pulse is not progressive, but that the ~~beat~~ *beat* of the heart and extreme arteries exactly coincide “ *quasi trajecto ful-*
“ *gure;*” at least, this, he says, is the case
in

in many animals: and he candidly owns, that for a long time he believed, that the motion of the heart and vessels was fully comprehended by God alone. After many experiments, however, and long study, he says, that he believed himself master of the subject, and published his opinions, partly that the world might judge of them, and partly that he might openly reply to some who had received these opinions *iniquo animo*, and attempted to injure his reputation. How little opposition these opinions met with is well known; with the exception of Riolanus, and a few others, physicians and surgeons immediately concurred in the new theory, which, for the last two hundred years, has been made to account for many of the phenomena of physiology, and powerfully influences practice in all its branches. It is, however, observable, that this new theory brought along with it no important improvement in the cure of diseases. Local blood-letting, and the open-
ing

ing of veins, continued as much in use as ever; and arteriotomy, known and practised among the antients, became nothing more fashionable than it had been, while the wounded artery was supposed to derive its blood from the right side of the heart. From the time of Harvey, however, we may date the general disregard of the writings of the antient physicians: for no student would take up his time in reading the works of men ignorant of the *circulation*; and the consequence has been, a succession and multiplication of theories, in physiology and disease, that baffles all description.

It will be allowed, that such a discovery as that claimed by Harvey, if really true, ought to have simplified medical practice, and afforded more distinct and correct views of the animal œconomy, and better means of relieving disease. We ought to have been able to point out the certainty derived from the discovery of a most important

tant fact, as applicable to general practice ; and if we really had so far exceeded the antients in accuracy of physiological research, a corresponding improvement in pathology was to be expected as a necessary consequence. A careful inspection of the antient authors will, however, teach us, that the cure of diseases was as well understood in their times as now ; if we make the necessary allowance for the different habits of men, which, in some instances, have introduced diseases unknown in antient times ; or have altered the symptoms of others, so that very different treatment has become necessary. In many cases it can be shewn, that, after the time of Harvey, we entirely lost sight of approved methods of cure in daily use among the antients, and are now recurring to them—as modern improvements—as, the cure of insanity by hellebore ; the application of cold water to the skin in certain cases of fever ; the use of the ligature to secure the principal vessels,

sels, before amputation; and the gradual division of the soft parts, to allow them to retract during the operation, as proposed by Mr. Brodie.

In short, the practice of Aretæus, Galen, Oribasius, Ælius, Paulus Ægineta, Actuarius, and many others, appears to have proceeded upon sound reasoning; and they, in fact, appear to have been as successful, while they believed the veins to contain

Αποβροχίσειον οὖν ἢ διαρραπείον τα φερόντα των αγγείων ἐπὶ τὴν τοπικὴν, καὶ διαδιείδον ἐπὶ τινων παν μέρει, ψυχρῷ τε προσαιονήσειον, ἐνίς δὲ καὶ φλεβοτομήσειον.

Archigenes, de Amputatione, apud Nicetam.

Ἐνιοὶ μὲν ἐν κενεσπασθόν ταχὺς ἐπιηδυνόντες κατὰ μιαν ἐπιβολὴν ὅλα τα σωματὰ ἐπιχαράσσειν, ἐπειὶα ἐκπρίξουσιν τα ὅσια. Οὐ γινέται δὲ ἀκινδύνῳ ἢ τοιαύτῃ ἀφαιρέσις. . . .
 Λίον ΜΟΙ δοκεῖ τα ἀσχεκότερα μέρη τα κωλύ προτέρῳ διελειν, ὥς κατὰ το ἀνλικνημιον ἐπειὶα πρίξιν, καὶ κατὰ τὴν των ὁσων πρίξιν, τα λοιπα σωματὰ διακοπείιν.—κ. τ. λ.

Heliodorus, apud eundem.

contain almost the whole of the blood, as we now are, while we pity their ignorance of the circulation.

That Harvey instituted many experiments, in order satisfactorily to prove his hypothesis, is very true : for he opened a great number of living animals, and was, upon the whole, a pains-taking anatomist. But from these experiments and demonstrations he establishes no one fact of which the antients were ignorant ; but founds his claim to discovery upon conclusions drawn from these experiments, as new. That, upon the application of a ligature to a limb, the veins swelled between that ligature and the extremity ; that the course of blood poured out from a wounded artery is from the heart ; and of the position and structure of the valves of the great vessels,—of these the antients had perfect knowledge. And yet upon these circumstances Harvey rests his whole system ; having recourse,
for

for the most part, to reasoning from probabilities, and overlooking entirely, as far as we can collect from his writings, the most formidable objections to his doctrine.*— Thus the circumstance of the arteries being found empty after death, with the exception of some grumous blood, found in the left ventricle, and commencement of the aorta, is explained upon the Harveian hypothesis by the assumption, that, at the approach of death, when the extreme vessels are losing their action, and the limbs turning cold—yet, at the very last moment, the

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nisus

* For example—when we find, in a case of pthisis pulmonalis, that an entire lobe of the lungs has been destroyed for some time before the patient's death—a case that not unusually occurs—how then is the continuity of this circulation preserved? In such cases, it is true, Mr. Abernethy has found the foramen ovale open, but that circumstance will not explain why effusion of blood does not take place in the thorax, or why penetrating wounds in the lungs are not attended with a fatal effusion of blood.

nisus of the heart and vessels is sufficient to throw the whole contents of the arterial system into the veins.

But the veins are not found distended after death; on the contrary, they shrink in many parts of the body, the cold condensing their contents, nor are they in capacity equal to receive, in addition to their usual contents, a quantity of blood sufficient to fill the arterial system, as the simple inspection of a blood vessel subject sufficiently shews. In cases of suspended animation, when the motion of the heart has ceased, it is reasonably to be supposed that the whole blood is then accumulated (as we say) in the venous system, although no marks of distension appear in the veins; yet, in such cases, life may be restored; and, according to Haller, no patient is to be despaired of, whose skin does not retain a pit from the pressure of the finger, shewing that the fat contained in the callular substance

substance is congealed, when, perhaps, we may also infer that the blood has become grumous in the veins.

In this instance the assumption made by Harvey appears, at once, unphilosophical, and contrary to fact; for, whether a man dies by protracted struggles, or is instantly killed by lightning, or the equally sudden effect of a noxious gas—still the blood is found in the venous system, and is never detained, as if in transitu through the arteries, unless these vessels have suffered injury, or death has been occasioned by suffocation.

Another strong objection to the hypothesis is this; that, although the globules of blood have been distinctly seen by many, no anatomist, or phisiologist, has yet discovered the anastomoses of the terminating arteries with incipient veins, by which these

red globules should pass. In cold blooded animals, this anastomosis is distinctly seen; but I speak of animals having lungs. That the veins may be injected from the arteries is very true, but it is also true that the vessels, immediately after death, become incapable of containing their natural contents; and it is not at all wonderful that a warm injection, propelled with some considerable force, should, by transudation, pass into the veins. Indeed Mr. Cruickshank particularly mentions that he frequently injected arteries, veins, and lymphatics, at one and the same time.

It appears neither to have occurred to Harvey, nor to his zealous friend Walæus, that, according to their new doctrine, a great, a seemingly insuperable difficulty occurs, in accounting for a continued circulation in limbs, *e. g.* the lower extremity, when the femoral artery has been obliterated for the cure of aneurism, or the saphe-

phena

phena for the cure of varices. In cases of the amputation of the thigh, the femoral artery pulsates strongly, and, if left unsecured, would pour out the greater part of the blood of the body, so as to occasion almost immediate death; the blood thus thrown into the vessel must, according to Harvey's doctrine, be returned continually to the heart, but no vein that possibly can return the blood from this artery exists after the operation, and regurgitation upon the heart is supposed impossible, on account of the valves at the origin of the aorta. It is said that anastomoses supply the functions of the vessels in their natural state; but if Harvey never could trace anastomoses in the extreme arteries and veins, none of his followers have pretended to exhibit them in large trunks, and, upon the dissection of stumps many years after the operation, not the slightest connexion between the visible arteries and veins is to be found.

Again, upon the supposition that the pulse ($\sigma\phi\upsilon\gamma\mu\omicron$) is really the progress of a portion of blood propelled, at certain intervals, through the left ventricle of the heart, the question occurs, why is the beat of the heart, and that of the most distant pulsating arteries, exactly synchronous? The motion of a fluid, propelled through elastic tubes, in diameter such as the arteries, and by a force much greater than that exerted by the heart, is still progressive, as may be ascertained by the fingers applied, and also by the eye—whereas the natural pulse of warm blooded animals is instantaneous, and altogether, as Harvey observes, “*quasi trajecto fulgure.*”

Another difficulty occurs in accounting for the velocity with which the blood is supposed to pass through the arteries and veins. According to the Harveian doctrine, the blood is in continual motion, through the heart and through the extre-

mities;

mities ; and, as the veins are considerably larger than their corresponding arteries, it follows, that in them the motion must be slower ; and as the velocity of fluids in rigid tubes is, *cæteris paribus*, in the inverse ratio of the squares of their diameters, we may suppose the velocity of the blood in the veins to be, to that with which it passes through the arteries, as 1 to 3. But, by the calculation of Keill, and others, the velocity of blood issuing from a wounded artery is not less than *ten* times as great as that with which it issues from a vein of nearly the same size ; and the truth is, that, supposing the pulse to be, as Harvey says, *impulsus sanguinis in arteriis*, the velocity of the blood in the arteries is not to be measured, for, like the electric shock, it is instantaneous, while the motion of the venous blood is so slow, that no means of ascertaining what it really is have been discovered, while the vessels remain entire ; and when vessels are divided, the velocity

with

with which their contents issue affords no information what, in the natural state, that velocity really is. * That whatever blood Harvey supposes propelled from the left ventricle of the heart, and the aorta, must have been received from the right side, and the cava, cannot be disputed, and the diameters of the two great vessels ought to furnish the data whereby to compute the velocity of the contained blood ; but, as general and established principles are here found inapplicable, a strong presumption immediately arises—that the blood does not circulate in the manner described by Harvey. It has been said, that but a part of the red blood propelled by the arteries is returned by the veins, but Harvey supposes the whole quantity returned, and it is very doubtful how far the blood is concerned in nutrition and secretions, although ~~it is~~ essential to life ; and one fact is admitted by the most respectable authors, that, after death has been occasioned by absolute starvation,

vation, the quantity of red blood is still very nearly the same as in the healthy body.

Then what becomes of the arterial blood, transmitted to a limb when the principal vein is tied? This objection had been proposed to Walæus, and it was asked why, upon tying the arm, in order to perform blood-letting, when the veins are compressed, and the arteries continue to perform their office, a great congestion of blood does not take place below the ligature; whereas, in fact, the veins rise as completely within a few seconds, as after so many minutes; and, if the ligature be kept on for a considerable time, they actually subside? To this he replies, that it *may be* the vein has not been completely closed by the ligature, and that, by the small openings still left, the blood may escape towards the extremity; but if the vein, say the saphena, has been taken up with two ligatures, and divided, as in varicose cases, what happens then?

then? To this too it would be answered, that the circulation would be carried on by anastomosing branches. But, although this is merely begging the question, because the principal channel by which blood is conveyed from the limb towards the heart cut off, there is no provision made by nature to remedy the defect immediately, let it be supposed true—and another case of even greater difficulty comes to be accounted for.—Suppose the axillary or subclavian artery obliterated, where no branch has yet been given off to supply the arm, other than the small branches that surround the *os-humeri*, at the articulation; how happens it that, even in this case, when not a drop of arterial blood can reach the hand, the veins on the back of it, and up the arm, remain turgid? According to the Harveian hypothesis, the heart is every instant exhausting the blood from the veins, and, in an arm thus situated, the venous blood ought to have disappeared, as soon as

no further supply could be furnished by the arteries; yet that this does not happen is proved by experience, for the veins of the arm have remained turgid for months after the artery was destroyed at the axilla, and till death, although the limb remained cold all the while.*

It

* *Extract of a Letter from Dr. Barclay.*

“ EDINBURGH, Jan. 26, 1815.

“ The case of aneurism, to which you refer, and of which I have still the preparation, was in the left subclavian; the patient had complained of it twelve months before I saw it, and, about three weeks after I saw it, it had disappeared. The arm was cold from the commencement, (*period of obliteration*), and till death, but an additional covering of flannel prevented any uneasiness from that cause. He survived the obliteration of the subclavian eighteen months, if not two years, and, for a great portion of that time, enjoyed tolerable health. With regard to your question concerning the veins of the arm, I was not prepared to give any answer till last evening; I had only thought of the arteries, and ascertained that there was no pulsation at

It has already been noticed, that no anatomist has ever been able to shew the inosculation of the extreme arteries with veins while

the wrist. I thank you, however, for the question ; it is highly proper and interesting, and will be of use to me in my future observations on similar cases. The answer to it was sent me yesterday, in writing, by Mr. Allan Walker, an intelligent and observing Surgeon, who regularly attended, and was the first who pointed out to me, and procured me the preparation."

"I shall copy his Note verbatim :—*Dear Sir—*
 ' With regard to the state of the vessels in that
 ' case of aneurism to which you were alluding this
 ' morning, the veins on the back of the hand were very
 ' turgid. Your's truly,

South Bridge Street.

A. B. WALKER."

"I was very anxious to have had the whole arm, to have injected it, but to obtain it was impracticable.—My own idea is, from a beautiful preparation in my own possession, from those which I have seen in the possession of others, and from what I have read in Scarpa, and others, that no limb is preserved, unless the circulation of even red blood be continued in the lateral vessels, which are always enlarged, and often rendered tortuous, from encreased impetus."

while the compages of the body remains perfect, nor can a single instance be adduced of any direct communication formed between newly produced arteries, after obliteration of a main trunk, (whether by disease, or otherwise,) and the veins of that limb. The arterial *surculi* shoot out as new branches from a pollard, but are guided, in their growth, by the general shape of the limb, and varied resistance they meet with from surrounding parts; and were it to be granted that, after having gained full extension, they could again anastomose with the extreme veins, what becomes of the circulation when they have newly begun to shoot, or when they have reached, it may be, half way down the limb, and the contents of large veins having no possible communication with them whatever? It will not be said, that when the iliac is tied, or even the femoral artery, any arterial blood can reach the toes, and yet the veins of the foot and leg contain blood, as if no obstacle had intervened in the artery—the limb

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only turns cold, as we may infer from the case given by Dr. Barclay.

In certain cases published by Mr. Astley Cooper, in the transactions of the Medical and Chirurgical Society of London, accompanied with engravings, he particularly describes the enlarged and new branches formed after the obliteration of the main artery, but, like Dr. Barclay, he appears to have paid no attention to the veins, nor even to the approximation of the different vessels. In some of the patients, who lived for years after the operation for aneurism had been performed high up in the thigh, the engravings represent the arteries as terminating near the middle of the leg, but none appear to have reached the feet.*

But it is apparent from the writings of all modern Physiologists, that they think
themselves

* Transactions, Vol. IV. The appearances in the Engraving, given Vol. II, is different.

themselves bound to reconcile all phenomena to the Harveian hypothesis, and to suppose all kinds of adminicles to support its probability. Haller, a most honourable man, and pains-taking experimentalist, tells us that, upon tying an artery, the part next to the heart swells, and that beyond the ligature *discharges itself of its contents*, although he professes to believe, and certainly did believe, the doctrine of Harvey and Walæus, who referred the pulse entirely to the action of the heart. When the artery is compressed by a ligature, its communication is, for the time, cut off from the source of life and motion; and it is merely because, in the dead body, and where ligatures have been applied, the arteries have been found empty, that our Physiologists have supposed them possessed of some indescribable contractile power, which, even in *articulo mortis*, and after ligatures applied, propels their contents, and leaves not a drop of arterial blood to be seen. It

is, however, of consequence to consider more particularly the opinions of Haller, because, after many experiments on living and dead animals, amounting, as he tells us, to more than two hundred, although he qualified the opinions expressed in his physiology, he yet rested convinced of the reality of the circulation.

“ D’aborde je me suis assure” (says he)
 “ que le sang pousse par le coeur, dilate les
 “ arteres, et forme ce battement, qu’ on ap-
 “ pelle le pouls.*...Le pouls cesse d’etre
 “ sensible dans les arteres qui n’ont qu’un
 “ sixieme de ligue de diametre. Je l’ai
 “ observe sur les membranes des intestins,
 “ d’un animal vivant a la derniere courbure
 “ d’un artere,” &c.

Here, at the very outset, the illustrious writer declaring his conviction that propelled

* Deux Memoires sur le Mouvement du Sang.

Lausanne, 1756. p. p. 33. et seq.

led blood is the cause of the pulse, and that he has observed it in very small arteries, appears to overlook the circumstance that the pulse of the heart and extreme vessels is exactly synchronous, a circumstance that is altogether irreconcilable with the progressive motion of blood, by whatever force propelled, in elastic tubes, and particularly as it is asserted that the sum of the diameters of arterial branches exceed considerably that of the aorta. He, however, differs from most Physiologists of his time, and contends that the velocity of the blood is not diminished in the smaller arteries—a position which it is not easy to maintain; but to this conclusion, he says, he was led by observing that, after passing through an aneurismal sac, the blood recovers its original velocity. Why the observation should have led to this conclusion is not very apparent, although he speaks of it as of very great importance, and destroying almost entirely the doctrine maintained by Keill,

and others, of the gradual retardation of the blood in the smaller arteries.

But as Haller agrees that the sum of the diameters of the arterial branches is greater than that of the aorta, he cannot possibly suppose, or maintain, that fluids move with equal velocity through wide and contracted channels, the quantity being always supposed equal; because the supposition is at direct variance with fixed principles. His experiments were principally performed upon fishes and frogs, and comparatively few on warm blooded animals. He, however, admits that there is sometimes an *oscillation* of the blood in the arteries—sometimes a *retrocession*—and sometimes, he says, the arteries are found entirely empty.—“ Ce phenomene est peut etre
 “ cause de l’erreur dans laquelle les an-
 “ ciens sont tombes en croyant, que les ar-
 “ teresne contenoient que del’air. Il est bien
 “ certain, qu’elles sont quelque fois entiere-
 “ ment

“ ment vuides quoique des grands hommes
 “ ayent soutenu le contraire.”

The contractile power of the arteries, which many Physiologists assert—because they think it accounts for the empty state of the arteries after death—Haller denies. He says, that arteries and veins, whether irritated by a lancet, or scalpel, or touched with spirit of nitre, so as to change the consistence of the blood within, undergo no change, nor manifest any contractile power. Farther, he says, that ossified arteries pulsate when neither susceptible of dilatation nor contraction.—“ On vit très long tems
 “ avec presque toutes les arteres ossifies,
 “ puisqu’ on trouve souvent dans les ca-
 “ davres une suite de lames osseuses depuis
 “ la tete jusqu’ au pied, entre la tunique
 “ musculieuse, et la tunique interne, des
 “ arteres des gens qui pendant leur vie
 “ avoient rempli toutes leur fonctions, et
 “ ne s’etoient plaints d’aucune maladie,
 “ dependante

“ dépendante du derangement de la circu-
 “ lation.*.....Ces viellards, dont les ar-
 “ teres se sont ossifies, se sont promenes,
 “ ont eu du pouls, ont conservè leur chaleur
 “ naturelle, et out fait toutes leurs fonc-
 “ tions pendant un tems considerable.”

This language is very explicit, and be-
 lieving the facts stated, on authority so
 highly respectable, we must be convinced
 that the supposed contractile power and
 great elasticity of arteries is a mere fiction;
 invented to help out the received doctrine
 of the circulation. It is not a little asto-
 nishing that, convinced of these facts, as
 Haller certainly was, yet we find him,
 throughout the work quoted, supposing the
 artery below a ligature to empty itself after
 the ligature is applied.—“ Quand on lie
 “ une artere, la partie au dessous de la li-
 “ gature chasse egalement dans les veines
 “ le

* P. 139, et seq.

“ le sang qu’ elle contient ; si l’on fait
 “ deux ligatures a l’artere le sang compris
 “ entre deux passe également dans les ra-
 “ meaux voisins.”*

It is true that he mentions these points as ascertained by others, and quotes Drelincourt and Schwenke ; but that he himself, believing in the doctrine of the circulation, must have believed the arteries possessed of this extraordinary power, is evident, for he could not otherwise account for their being found empty, under the circumstances mentioned. The experiment of applying two ligatures to an artery, in the living subject, to ascertain whether blood is to be found between them, is certainly well calculated to establish the fact, whether blood is really contained in the arteries, or not ; but when an artery is, for this purpose, detached from the surrounding parts, tied,

and

* De Causes de Mouvement du Coeur, p. 137.

and found empty, it is a mere subterfuge to say that the blood had escaped into the neighbouring branches, when it is evident that no person of common sense, trying the experiment, would chuse the part of an artery giving off branches, or if by chance they should be seen, would leave them unsecured.

It has been already observed, that Haller made the greater part of his experiments on fishes and frogs, whose hearts, when compared with the human, are essentially different, but many of his experiments were made on warm blooded animals, and are valuable.

He observed, that upon opening a vein, the blood flowed to the aperture both from above and from below ; and as we know that, in amputation, it is sometimes necessary to secure veins by ligature, it is certain that, in the human body, the course of
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the blood in a wounded vein is often from the heart—although, in the natural state, its regular motion is towards it, and from the extremities. The sudden flow of blood upon slackening the ligature, in venæsection, he says, is not to be accounted for by any supply to be derived so immediately from the capillary arteries, but from the removal of pressure on the ascending vein.

Modern Physiologists enumerate four different terminations of arteries—in veins, exhalants, in cells, and in the excretory ducts of glands. The ancients believed that all blood vessels, or, to speak more correctly, both arteries and veins, terminated on the surface, or in cavities. Their opinion was, that redundant fuliginous vapour, and perspirable matter, was thrown out by the extreme arteries, and that moisture was derived from the surrounding atmosphere by the veins, and hence the dictum of Hippocrates, *εἰσπνέον καὶ ἐκπνέον*
ὁλον

ὅλον το σῶμα. They believed that the nourishment of the body takes place by venous absorption from the stomach and intestines, and that the extremities of veins on the surface absorb the needful quantity of fluid from the surrounding air. The lacteals they termed *φλεβες λευκαι*, but it seems uncertain whether they had ever observed the lymphatics.

It has been asserted by modern Anatomists, that red veins do not absorb; and Dr. Hunter and Mr. Cruickshank instituted several experiments, the result of which seemed to them decisive of the fact. They opened animals while alive, and, emptying the veins of portions of the intestines, the trunks of the arteries supposed to supply them being secured, they injected into the intestine warm milk, or starch, tinged with blue, or other colouring matter, and, after the liquids had remained for hours in that situation, the abdomen closed
up,

up, and the animal still living, the veins were found, upon inspection, to have absorbed no part of the coloured fluid, although the lacteals were evidently performing their proper functions. These experiments appeared to Cruikshank quite conclusive; but it must be observed, that the ancients believed the red veins to absorb the simple aqueous fluid only—and that fluid these gentlemen never tried, although Kaw Boerhaave, Professor of Anatomy at Petersburg, had informed the world that he had injected water, by the stomach and intestines of a dog, recently dead, so as to wash away all the colouring part of the blood in the veins of these parts. Coloured substances will scarcely pass the lacteals, the colour and sensible qualities of chyle at all times remaining much the same; and how men of such eminence as Hunter and Cruikshank could expect veins to take up any thing different from their proper pabulum, it is difficult to conceive. It seems

almost as extravagant as it would be to assume that, because a horse had rejected ardent spirits, he, therefore, would not drink of the pure stream. Besides, all experiments made upon the living body under the influence of extreme pain, when the whole animal economy suffers from violence, must afford results but ill calculated to improve our knowledge of the mode in which the vital powers are naturally exercised, and never have added any thing of real importance to medical science. Experiments made upon the dead body, by injection, are liable to still stronger objections, and, as far as they have been received, have, for the most part, rendered no service to physiology. Anatomy certainly teaches us much of what we know in nosology and pathology, but physiology must be learned from careful observation of the natural functions of the human body, yet in vigour, and uninjured by violence. We trace, with much advantage, the vestiges of
of

of disease after the patient's death, because we are taught to form a more correct notion of the real state of a patient complaining of like symptoms to those of which our patient died—but the natural functions of parts can be but imperfectly collected from anatomical investigation, because these functions depend upon an agent, whose mode of action is no longer observable when life has fled, or is so much disordered in its operation, when the body is wounded, that no certain conclusion can be drawn from the appearances.

It is not surprising that different opinions have been formed, on the question, whether blood be naturally contained in the arteries, or not. When wounded, they pour out blood, and the conclusion of those who judge merely from this unconnected fact would be, that they are naturally full of that fluid, as well as veins. The doctrine of Erasistratus was founded upon more accurate
 E 2 observation;

observation; he admitted the fact, that wounded arteries pour out blood—but affirmed that it was derived from a distance, immediately upon the infliction of a wound; and as we must bear in mind that both he and Herophilus were expert anatomists, and gave names to some of the most delicate and minute parts of the body, which remain unchanged to the present day,* we must admit that their means of forming a sound judgment on the question, or, in other words, of ascertaining the fact, were fully equal to our own.†

Not only did they dissect dead bodies, but those of living criminals, in great numbers;

* Retina Oculi—tunica arachnoides, &c. &c.

† Herophilus ille Medicus aut Lanio qui *sexcentos* homines exsecuit, ut naturam scrutaretur, qui hominem odit ut nosset ; nescio an omnia interna ejus liquido explorarit ; ipsa morte mutante quæ vixerant, et morte non simplici, sed ipsa inter artificia exsectionis.

bers; and such dissection, although cruel in the extreme, certainly affords much better opportunity for experiments to ascertain the truth on this question, than that practised in our times. Their school, it is said, fell into disrepute, because it required more study than was thought necessary; and Pliny, speaking of the doctrines of Herophilus, says, very candidly, “Deserta
 “deinde et hæc secta est, quoniam necesse
 “erat in ea *litteras* scire.” One experiment, however, may, with much propriety, be tried on the living body at the present day, and it is an experiment that appears decisive of the question. In those of advanced age, the temporal artery becomes very distinct, and even prominent. It is of the same colour with the surrounding skin, while the veins in the neighbourhood are, as usual, blue. Its pulsation is distinctly perceptible by the finger, and, if firmly pressed, so as to stop that pulsation, it appears a little raised on the side of the heart,

but it is still colourless. Divide it freely, as in cases of violent ophthalmia—and the first blood thrown out will have the appearance of bloody vapour for two, three, or four pulsations—afterwards the blood becomes of a darker colour, and the vessel acquires, by degrees, the deep colour of a vein, and then the blood does not flow *per saltum*, but equally, as in common blood letting.

Equally

The superficial arteries, easily seen in whatever part of the body, will afford the same result; and as our doctrine, received from Harvey, is, that the arteries are, in the natural state, full, and all full of blood, this simple experiment, which every Surgeon may verify for himself, goes far to prove an *alibi*, and decide the question without farther investigation.

In their zeal to promote and maintain the Harveian hypothesis, teachers of anatomy have said, that the differently constituted

tuted.

tuted coats of arteries are not diaphanous, so as to allow the blood to be seen in them, as in veins. Injections, however, appear just as distinctly in arteries as in veins, and the simple experiment just mentioned proves that there is no foundation, in truth, for the allegation that their coats are not pellucid.*

Whether, after death, the arteries contract more than the veins, has been doubted; but such contraction can be supposed to proceed from no vital power, and, consequently, can prove nothing in the present argument. The changes which arteries undergo after death, as Haller well observes,

* It is true that, in injecting the recent subject, the arteries are not diaphanous; but maceration is the cause of this—for, without such maceration, even the aorta changes colour, when filled of warm blood.

observes, “ Appartiennent aux forces mor-
 “ tes, et continuent d’ agir pendant des
 “ annès entières, apres la cessation totale
 “ de’ l’ action des fibres circulaires comme
 “ on le prouve par l’ exemple des arteres
 “ ombilicales, du conduit arteriel, et des
 “ aneurismes.” He adds, “ Je mets dans
 “ ce meme ~~fang~~ *fang*, la force qui fait qu’ une
 “ artere coupée se retire, et qui est encore
 “ plus forte, et plus sensible dans les ten-
 “ dons, ou dans les ligaments, quoiqu’ ils ne
 “ soient, ni creux, ni irritables.”

It is difficult to conjecture what could
 have led Harvey to form an hypothesis so
 inconsistent with the doctrines of the most
 enlightened ages, and apparently so com-
 pletely at variance with plain and evident
 facts. It has been said that the engravings
 of the valves of the veins, published by Fa-
 bricius, first suggested to him the notion
 of circulation of red blood, and his engrav-
 ings, calculated to shew the effect of these
 valves,

valves, tend to confirm the report. Had he, with less obstinacy, denied the existence of lymphatics, and taken the trouble to examine their structure, he would have found valves, of the same construction with those of the veins, belonging to vessels in which no kind of circulation can exist, for they originate on surfaces, and discharge their contents into the venous system. The structure of these vessels, at least of the lacteals, was better known to the antients than to Harvey, as we may infer from their frequently mentioning them as $\phi\lambda\epsilon\beta\epsilon\varsigma\ \lambda\epsilon\upsilon\kappa\alpha\iota$, while Harvey died denying their existence.

From his whole work, "de Motu Cordis," there is reason to believe that he was not well versed in the writings of the antient Physicians; for if he had, he could scarcely have formed the supposition, that they had carelessly overlooked appearances, which, according to him, prove the circulation of red blood, and are obvious to the meanest capacity.

capacity. With what reason could Harvey take upon himself to say, that the common appearance of the arteries being found empty after death had probably *imposed* upon Erasistratus, a Physician who, as well as Herophilus, had performed hundreds of cruel dissections on the bodies of criminals,* “adhuc remanente spiritu,” that he might discover the real functions of the heart and vessels, and the organs whose actions cease immediately after death? Could Harvey possibly believe that the pupil of Plato, cotemporary of Euclid, the son-in-law of Aristotle, and friend of Theophrastus, had, from want of accuracy, or ignorance, omitted to perform those simple experiments upon which he founds his hypothesis? That he did not know that a ligature makes a vein swell on the part next to the extremity, or that a wounded artery pours out blood which issues from the heart?

* Celsus.

heart? Could Harvey believe that they who gave names to the valves of the heart, which remain even to this day, had left it for him to form the first rational opinion of their use; or that, when sciences were at their highest perfection, Physicians alone remained grossly ignorant, or believed in absurdities? Whatever work of art of that age has come down to us, its excellence ascertains it æra; and were it not that the writings of antiquity have suffered much by the ignorance or carelessness of transcribers,* and the ravages of time, they would, at this day, be our most perfect models. Long after that age, Athenæus brings
in

* Of error in transcription a beautiful and sublime passage of Aretæus affords a strong instance. In the close of his description of ardent fever, he says, that, on the approach of death, the patient foresees things to come, and foretells future events—the bystanders, says he, think they are delirious. The edition of Turnebus, followed by all other editions, has ἄλλο φασὶ δοκεῖσι—whereas the real reading is most evidently αλλοφασσιν

in Galen, as one of his Deipnosophists, a philosopher worthy of the first place in literature. And although Galen has, most unwarrantably, as it would appear, attacked the doctrines of Erasistratus, “*nimis animose*,” as Riolan observes, yet his works do him infinite honour, and will remain an illustrious monument to posterity of what genius and industry can effect.

In his time, he admits, that anatomy was not so accurate as in the times of the Asclepiades, but yet he himself is more minute than many demonstrators of the present day, and, in nosology, describes minutiae
altogether

δοκεῖσι, videntur delirare. In the same passage there occurs in the text, in the princeps edition of Turnebus, and the error is copied by all following editors, *πολλα τε εν αερι ἔρρεσι*.—Petit has rendered the passage *πολλα τε εν ἀερί ὀρεσι*, which at once renders it intelligible.—We have not a single page of Hippocrates without *variæ lectiones*, and *σφαλματα*, which sometimes represent the author as contradicting himself.

altogether neglected of late years; so true is that which was said by Isaac Vossius, that, even in his time, “ Vix aliquem hoc “ seculo invenias medicum qui observata “ Galeni vel intelligat vel curet.”

Although it may seem a digression from the subject of a publication of this nature, I cannot help bringing forward what Galen considers as the necessary qualifications of a student of medicine. I shall give the sense from his translator, Victor Trincave-
lius, the original being subjoined in a note.*
The student must be “ primum natura
F perspicax,

* Πρωτον μὲν ὄξεια φύσις ὥσπερ ὅπερ εἰς ἐκδιδασκῆσαι μαθήματα λογικὸν ἑτοιμῶς ἔπρεσθαι.—δεύτερον δὲ ἢ ἐκ τῆς παιδικῆς ἡλικίας ἀγωγή τε καὶ ἀσκήσις, ὡς ἐν τοῖς πρώτοις γενέσθαι μαθήμασι, μαλιστα δ' αὐτὸν ἐν ἀριθμητικῇ, τε καὶ γεωμετρικῇ γυμνασάσθαι δεῖ, καθάπερ καὶ Πλάτων συμβάλλουσι — τρίτον ἐπὶ τέλοισι ἀπάσιν ὑποσχεῖν τὰ ὅλα τοῖς κατὰ τὸν αὐτὸν χρόνον ἀριστοῖς εἶναι δοκοῦσιν — ἔτι τε τέταρτον, αὐτὸν εἶναι φιλοπονοῦντα, ὡς μὲν, καὶ ἡμέρας μὴτε νυκτὶ

perspicax, ut edoctus facile quamcunque rationalem disciplinam consequatur. Alterum, educatio exercitatioque a teneris annis in primis disciplinis, in primis vero operæ pretium fecerit si juxta Platonis preceptum se in geometria et arithmetica exercuerit. Ad hæc tertium quibusque optimis

sua

ἐκμελείαν ἄλλο πλὴν τῶν μαθημάτων.—Εἶτα πεμπὸν ὅπως ὀλιγίστοις ὑπὴρξεν ἀληθείας ὀρεχθῆναι, καὶ τῶ σπουδᾶσαι μόνον ἐν ἅπῃ τῷ βίῳ κατὰ φρονησάντα τῶν ἄλλων ἁπάντων ἃ τοῖς ἄλλοις διεσπῶδασαι.—Πρὸς τοῖς ἐκτὸν ἐκμαθεῖν τινὰ μέθοδον ἢ διακρίνειναι τὸ ἀληθὲς τε καὶ τὸ ψεῦδος. Οὐ γὰρ δὴ ἀποχρηστὴ γέ μόνον εἰς τὴν εὕρεσιν ὧν ζητοῦμεν ἐπιθυμῆσαι τῆς ἀληθείας, ἀλλὰ καὶ χρὴ καὶ δύναμιν τινὰ τῆς εὕρεως πορίσασθαι. Ἐβδόμον ἐπὶ τοῖς ἅπασιν ἀσκησάτω τὴν μέθοδον, ὥς μὴ γινώσκῃ μόνον ἀλλὰ καὶ χρῆσθαι δύνασθαι. Εἰ γὰρ δὴ τοῖς ἐξηροῖσιν ἐλάττω τεχνὴν μετρηχομένοις οὐχ ἱκανὸν εἶναι δοκεῖν τὸ γινῶναι τὴν μέθοδον, ἄλλ' ἐν ἅπῃ τῷ βίῳ τὴν ἀσκήσιν ἑαυτοῖς μεταχειρίζονται, πολὺ μᾶλλον τοῖς δ' οὐτῷ μεγάλῃ ζητοῦσιν ἐκ ἀποχρηστῆς μόνως ἐκμαθεῖν τὴν μέθοδον; Εἰ μὲν ἐν ἑνὶ τῶν ἐξηρημένων ἐνδοῖσι τῷ καθ' ἑαυτὸν τῆς ἐπὶ τὴν ἀληθεῖαν ὁδοῦ, δίκαιον ἐστὶ μὴ παντὶ τυχεῖν ἐλπίζειν ὧν ἐφίεται. Εἰ δὲ ἅπαντα ὑπάρχει, τί κωλύει ζητεῖν τὸ ἀληθὲς ἐπ' ἐλπίσιν ἀγνοίας;

sua tempestate habitis preceptoribus se auditorem præstitisse. Quartum laboris eo esse patientissimum ut diu nocteque nihil aliud commentetur quam quæ ad disciplinas spectent. Quintum quod paucissimis datum est, veritatis amore esse captum; soloque illius studio, toto vitæ curriculo teneri cæteris omnibus neglectis quæ à quamplurimis aliorum multifieri solent. Sextum aliquem præterea methodum, qua verum a falso discernatur didicisse. Neque ad eorum inventionem quæ inquirenda nobis proposita sunt, satis fuerit veritatis desiderio affici, nisi etiam viam aliquam eam inveniendi expeditam habeat. Septimum insuper eam methodum ita jugi exercitio tritam habere, ut non modo norit, sed etiam valeat. Porro si oratores, qui in arte longe minori versantur non sibi satis esse methodum novisse putant, nisi illam assidua exercitatione, per totam coluerint ætatem; quanto minus iis qui magna adeo sectantur methodum didicisse sufficiet? Itaque si vel unum horum

quæ recensuimus in illo desideretur, qui ad viam veritatis introducendus est, non erit admodum sperandum illum posse sui voti fieri compotem. Si vero omnia cumulata adsint, quid deinde vetat quo minus *veritatem* etiam bona spe exquiramus?"

If such were the qualifications deemed necessary for the study of medicine in the time of Galen, we cannot believe that they were rated lower, or that discipline was less severe, in the time of Plato and Aristotle; and if we reflect for a moment upon the plan of medical study of modern times, we shall certainly exceedingly flatter ourselves if we claim the superiority, in selection of talent, or the manner in which we prosecute the investigation of truth.

But Harvey supposes the antient Physicians to have been both ignorant and careless, and that, as has been already said, they were incapable of giving any rational account

count of the uses of parts described accurately by themselves ; and yet, while he thus presumes every thing against their good sense and accuracy, he himself takes no notice of the simple and self evident fact—that *the human body does not contain the blood necessary to fill both arteries and veins, at one and the same time, according to his hypothesis.* He admits that the arteries are found empty after death, and does not consider that, in a full grown man, four pounds and a half at least of blood would be necessary to fill them, in addition to what is found in the veins, so that his circulation might be complete, and the blood go on, as the College of Physicians express it, *circulari gyro.*

At death, the superficial veins subside, and there is an accumulation of blood about the heart, which the antients believed to proceed from the extinction of the elastic vapour, which, during life, occupied the

left side, and aortic system ; so that blood is sometimes found in the left ventricle, for they believed that, in perfect health, the vital spirits on the left side of the heart, and blood on the right, counterbalance each other, and each forces forward to supply the place of the other, when withdrawn. But, in the human body, there is not more blood than moderately distends the venous system, and we know, that the moment a divided artery, pouring out blood, gives it in a continued stream, it pulsates no longer, and the blood is of the same dark colour as that yielded by a vein. All this is admitted by Harvey in express terms, and he thinks it sufficient to say that, in the case of blood flowing freely from a wounded artery, “ *Sanguis præterit, non distendit.*” But why does a divided artery pulsate at first, and gradually lose that pulsation, the other arteries continuing their action, and the patient conversing, and in good spirits? The blood is *præteriens*, while it is thrown
out

out *per saltum*—it is *præteriens* when, immediately after, it flows quietly as from a vein, and is of the same dark colour as venous blood, yet in the one case “*distendit*,” in the other not at all. If Harvey’s account of this appearance were just, if the artery were naturally full of blood, it ought to lose pulsation the moment it is divided; but that is not the case—the first jets from a divided artery are thrown out with great force, the blood is of a light appearance, as if mixed with vapour, and falls in small drops, and this continues for several pulsations; but an alteration is taking place every instant, and the moment the artery is full, pulsation is lost, and the colour is changed.

In this instance the reasoning is evidently unsatisfactory. In the following passage, in which he supposes gross ignorance and want of observation on the part of Erasistratus, it is still more faulty, and the

the passage concludes with an assertion which must lead us to believe that he was not quite so much enamoured of *truth* as Galen wished his pupils to be.

“ Vacuitas arteriarum in corporibus mortuis* (quæ forsan imposuit Erasistrato ut arterias spiritus tantum aërios continere existimaret) inde evenit, quod quando subsident meatibus occlusis pulmones non ulterius respirent, et per ipsos sanguis libere non potest transire : perseverat tamen per temporis spatium cor in expellendo ; unde et sinistra cordis auricula contractior et ventriculus ; pariterque arteriæ inanitæ et (non sanguinis successione repletæ) vacuæ
 apparent.

* From this passage it would appear that Harvey did not know that Erasistratus had confirmed his doctrine of the vital spirits contained in the left side of the heart, and arteries, from the dissection of living criminals—otherwise how could he say that the *empty state of the arteries, after death, had probably imposed upon the ancient Physician*?

apparent. Sin simul cor pulsare cessaverit, et pulmones respirando transitum præbere, ut in iis qui aqua frigida submersi suffocantur, aut syncope et morte subitanea extinguuntur, pariter repletas venas et arterias reperies."

Harvæus ad J. Riolanum.

In this short passage much is assumed that is really unfounded, and that is asserted which is really false. Harvey had no right to suppose for a moment that Erasistratus, whose dissections of the living bodies of criminals amounted to some hundreds, and who expressly denied the presence of blood in the arteries, unless forced into them by wounds, or disease, was imposed upon by the common appearance after death. And his reasoning, by which he attempts to account for the empty state of the arteries after death, is altogether inconclusive; for he first assumes that the pulse is really "*impulsus sanguinis per arterias;*"

“*arterias ;*” and the existence of the blood returned from the lungs, the real cause of the distension and consequent contraction of the left ventricle, and then, after the lungs afford, according to him, no competent supply of blood to the left side of the heart, “*perseverat tamen per temporis spatium cor in expellendo.*” *In expellendo*—what? not blood, for, according to his own account, it is not supplied: and what *expells* the blood from the arteries, which, he allows, are found empty? He admits no other agent than the blood,* and yet he
supposes

* He entirely rejects the doctrine of antiquity, and denies the existence of *vital spirits*, and believes the blood the sole moving power of the heart and arterial system. To the formation of these vital spirits, the ancients believed a very small quantity of blood to be necessary—but this they believed to be furnished merely *guttatim*, *per foraminula septi*, and these foraminula Riolan declares that he was accustomed to demonstrate at his public lectures.

supposes an effect produced in the evacuation of the arteries when that blood is no longer present, and cannot stimulate the heart to action.

That the arteries are found equally full of blood with the veins in those killed by submersion

Gassendus particularly describes the *foraminula septi*, as demonstrated, in his presence, by Payanus. His words are—"Is itaque spathulam usurpans mediostium cordis penetrare aggressus est. Id vero tentavit non recta ut alii, sed extremo primum ferro subingresso (mille siquidem januæ quæ septi est textura patent) progressum fecit levissime quippe ferrum, sursum, deorsum, et ad latera patientissime contorquendo exploravit semper ulteriorem aditum. Quid moror? Facta demum est in lævum usque sinum penetratio. Cæterum autem quia nos causabamur factam fractionem aliquam; jussit ipse novacula ad ferrum usque septum incidi, sectione facta, nihil prorsus fuisse temeratum deprehendimus, sed meatum solum, sed canalem observavimus (etsi per varios quasi mæandros, et cuniculos circumductum) membranula tenuissimâ politissimaque intectum."

submersion in cold water, by syncope, or any other sudden death, is really untrue in fact, although a small quantity of blood is found in the left side of the heart, and contiguous aorta. It is mentioned by all our anatomists of respectability, that, wounds of the considerable arteries, or diseases which enlarge their cavity, out of the question, the arterial system is uniformly found empty after death.* In this instance it is clear that Harvey made an unsupported assertion in aid of his hypothesis. He does not say that he really found the arteries, in such cases of sudden death, full of blood, but he tells his reader that *he* will find it so, an assertion altogether contrary to the fact.

When I say that the arteries are uniformly found empty after death, where the organs

* In some cases of suffocation the blood is found to have passed partially into the arteries.

organs have not been injured by violence, or disease, I do not forget the history of the blue boy,* for blood will certainly be found in the arteries of blue children, after death, and to me it appears that their feeble and irregular pulse is owing to its presence in these vessels during life, for, in them, the *foramen ovale*, or *ductus arteriosus*, is open ; or, by some disease, or malconformation, the blood passes from the right side of the heart to the left. But, generally speaking, the arteries are found empty, and it is utterly impossible that both they and the veins can be full of blood, at the same time, in the healthy living body.

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* The complexion of the "blue boy" has been attributed to the want of oxygenation of the blood in the lungs. If by warming a recently dead body in a bath to 98° of Fahrenheit, liquifying the fat, and injecting blood, of the usual temperature, into the aorta ascendens, while the descending trunk is tied, to save waste—if thus we produce the exact complexion of the "blue boy," the chemical solution may be spared.

The fallacy of Harvey's reasoning, in accounting for the empty state of the arteries after death, appears to have put his followers upon the study of the *irritability* of these vessels, so that they might account for the phenomenon by assigning a contractile power to their coats.* To me it appears that this attempt has entirely failed. Haller's experiments I have already mentioned, and those instituted lately by Dr. John Thomson, of Edinburgh, who appears to

* As no attempts have proved successful to shew the supposed contraction of the arteries in *articulo mortis*, so as to account for their empty state, a reference is made to the arteries of the umbilical cord, which are said to be very much contracted after the separation of the child from the placenta. The apparatus necessary for the life of the fœtus, while the lungs remain inactive, will, however, afford no illustration of the physiology of the human body, after a different life has been entered upon. The umbilical arteries, weak, and easily ruptured, with even a small degree of force applied, will, without doubt, contract by the action of cold, and

to have given a most candid account of his results, do not seem more conclusive, or to render it in the smallest degree probable that arteries empty themselves at, or after death. I have no doubt that irritation, by the point of a scalpel, or the application of acid preparations, may occasion a contraction of any part possessed of nerves, and muscular fibres ; but what can thence be inferred applicable to the natural contents of vessels ?

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what

I think it probable that a heat of 98° would again enlarge them, if applied within a few hours, to their former capacity. That they will pour out blood, if left unsecured, after the division of the cord, is very true ; but the fact has nothing to do with the present argument, for the *foramen ovale* is open, and the lungs have begun to perform their functions before the division is made ; so that neither blood found between two ligatures in the course of the cord, nor the effusion of blood from the simply divided arteries, afford the slightest proof of the natural presence of blood in the arteries, nor its circulation in the healthy human body.

what inference can be drawn applicable to the blood ?

A very simple experiment on a dog (for we have not now the facilities enjoyed by Erasistratus of opening human bodies alive) will ascertain whether any such contractile power exists in arteries. Let the thorax of the dog be laid open, the pericardium also opened, and a merciful enough way to terminate his sufferings will be to suddenly pierce the left ventricle with a scalpel, or to discharge a pistol ball through it. In either case life will be instantaneously extinguished, and the pulsation cease in all the arteries; very little blood being discharged from the wounded heart. According to Harvey's hypothesis, the arteries of this dog ought to be found full of blood, for the pulse being instantaneously extinguished, they could not propel their contents into the veins, nor could it return into the cavity of the heart, on account of the semilunar

semilunar valves. But if, even in this case, the aortic system is found empty, the conclusion is inevitable that the arteries do not naturally contain blood, and that no such contractile power is wanted in them, as the followers of Harvey contend for.

In such a case, where the left side of the heart is wounded, so that the ventricle is penetrated, the sudden death that ensues is evidently not from loss of blood, for very little is effused, and life continues for some days after a like wound of the right side penetrating into the ventricle, and pouring out several pounds of blood. It would appear that the opinion of Hippocrates was, in so far, right, who held that the *πνεῦμα ζωον*, the vital principle, resides in the left ventricle, for it is certain that, upon the infliction of a penetrating wound, the words of the poet are literally true—

“Omnis et unâ

“Dilapsus Calor et in ventos vita recedit.”

Diemerbroeck relates a case of this kind very distinctly :—" Vidi quondam Novio Magi virum cum alio pugnantem, cui, me adstante, medius thorax ab adversario suo, perfossus fuit gladio, ictu sinistrum cordis ventriculum (quod postea in aperto cadavere vidimus) penetrante. Ille eo ipso momento quo vulnus accepit, quasi fulmine ictus concidit, moxque extinctus est. Cum autem concideret, statim accessi et ejus pulsum in carpo ac temporibus exploravi, sed nusquam arteriarum ullam pulsationem percipere potui, propterea scilicet, quod sanguis per vulnus cordis in thoracis cavitatem effluens non impellebatur in arteriam magnam, sicque sanguis arteriarum immobilis substitit, nec ulla arteria pulsavit. Similem casum antea etiam Leydæ videram."

Such is the rationale of this sudden death, given by a believer in the Harveian doctrine; but had he examined the arteries, and found them empty, he would have been
under

under the necessity of having recourse to contractility, or some other occult power, to account for the phenomenon. His clear description of the immediate extinction of life may be depended on, as it agrees with constant experience, that a penetrating wound of the left ventricle of the heart is instantly fatal. On the other hand, very considerable wounds of the right ventricle have been inflicted, and great effusion of blood has taken place, and yet the patient has lived for one or more days, and even used considerable muscular exertion after receiving the wound. Job. A. Meekren has published several such cases, observed by Tulpius, Bartholin, and others,* and from many authentic sources we are supplied with the like information.

As no fact can possibly be inconsistent with a true theory, and as it is self evident that

* *Observationes Medico-Chirurgicæ*, p. p. 152, et seq.

that there is not blood sufficient in the human body to fill both arteries and veins—as we see that arteries, as soon as they are filled with blood, do not pulsate—and that Harvey's reasoning to account for their being found empty after death, is altogether inconclusive—as an *unda* of blood propelled through an elastic tube must necessarily be progressive in its motion, whereas the pulsation of the most distant artery is exactly synchronous with that of the heart—the conclusion appears to me inevitable that the hypothesis is unfounded.

It, however, deserves notice that, although he affirms, in many places of his Book, *De Motu Cordis*, that, by the application of ligatures, he has produced positive demonstration of the actual existence of the circulation, which, he says, none can deny, unless those who disbelieve the evidence of their senses ; yet, in addressing the younger Riolan, he uses this expression :—

sion :—" Doctissimus vir mentionem fecit tractatus cujusdam sui de circulatione sanguinis; *utinam viderem forsā recipiscerem.*"

This is not the language of a man satisfied of the validity of his asserted demonstrations; for, after we have seen a fact by the common laws of evidence fully proved, we can never afterwards entertain doubt upon the subject; but we see that Harvey passes over the strongest objections to his doctrine, and argues from experiments, which, allowing them to be faithfully reported, are not conclusive. We know that the antients were in the habit of tying both arteries and veins, and believed the contents of the former to be propelled from the heart, while the motion of the blood in the veins, however slow, is towards the viscus. They believed that, by vessels, the whole body exhales and inhales, and would have found no difficulty whatever in explaining the results of all Harvey's experiments, upon principles altogether different
from

from his. But he imagined that the vital spirits of the antients had no existence; and, having formed his hypothesis, assigned life, motion, and heat, to the agency of the blood alone. How the world came to receive his opinion so readily, it is not easy to conceive; for, although the study of the Greek medical writers was upon the decline when he wrote, and very few of his medical cotemporaries could be called men of eminence, it is yet surprising that his inconsistency and unfounded assumptions were not more severely criticized than they appear to have been, by Riolan, Primerose, Parisanus, and others.

It is amusing to observe the ease with which Le Clerc, following the Harveian doctrine, presumes gross ignorance, or wilful error, on the part of Erasistratus.*

After

* It has been mentioned that Erasistratus attributed the light colour of the blood first poured out from an

After mentioning that it is surprising that this physician, who had so attentively examined the heart, yet embraced an absurd opinion concerning the natural contents of the arteries, and denied that they contain blood in the healthy state—"Il etoit aise de le convaincre par la vuë ; mais il avoit recours a ce subterfuge. *D'abord disoit il que l' on ouvre le ventricle gauche du Coeur, l' esprit evapore sans qu' on le voye, et ce ventricle se remplit a l' instant de sang.—S' il avoit eu Connoissance du MYSTERE de la Circulation, il n' auvoit pas ete si embarasse sur ce Article.*"

It

artery to the presence of vital spirits ; and he held the doctrine that, by venæsection, the vital spirits are also derived into the veins. And certain it is, that, in taking away blood from a vein, the last drawn is always the lightest in colour ; and, when several pounds are necessarily to be taken away, as in some severe attacks of pneumonia, the blood at last assumes the appearance of the washings of raw flesh.

It is to be suspected that the MYSTERY of the circulation (an excellent term supplied by Le Clerc) would not have cleared up many difficulties in physiology to this eminent physician, who had certainly done more to convince himself of the truth “*par la vuë*” than any other physician of antient or modern times, Herophilus alone excepted.

The question will naturally occur, why, if the physiology of Erasistratus was well founded, did Galen write so strongly against it, he who professed such regard for truth, and enjoined his pupils to prize it above all things during the whole course of their lives? With many great qualities, it is not to be denied that Galen was vainly ambitious, and often uses language against his antagonists unwarrantably gross, calling them “asses,” with other expressions of contempt, altogether unbecoming a philosopher. At the same time he may have been susceptible

susceptible of what we have heard termed the *odium medicum*; and while he wished to be considered as the founder of a sect, too little regarded the decencies of controversy. The following observation of Riolan upon this subject is, I believe, just:—

“ At sane videtur Galenus ambitiose, et animose, libros de venæsectione,” (he might have added the book “ an sanguis naturâ sit in arteriis,”) “ scripsisse, annum agens trigesimum quartum, cum videret Erasistratum in omnibus medicinæ partibus tanquam virum admirabilem prædicari.— Eo modo et Archigenem insectatus est, ut famam ejus deprimendo suam magis extolleret.”

Yet, upon the whole, Galen never believed that the arteries are naturally full of blood; his opinions were very nearly the same with those expressed, at a later pe-

riod, by Servetus,* who, although he has been said to have made a near approach to the discovery of the circulation, yet plainly shews, in the quotation below, that he never would have given his assent to the hypothesis, which is altogether inconsistent with his physiology.

Had it been true that Harvey, in the sixteenth century of the Christian æra, had discovered the important fact, that, contrary to the opinions of all antiquity, the arteries really carry red blood continually from

* In libro suo quem de Sacra Trinitate scripsit, hæc habet Servetus a physiologia deprompta.

“ Vitalis spiritus in sinistro cordis ventriculo suam originem habet, juvantibus maxime pulmonibus ad ipsius generationem. Est spiritus tenuis caloris vi elaboratus, flavo colore, ignea potentia, ut sit quasi expuriose sanguine *lucens vapor*, substantiam in se continens aquæ aeris et ignis; generatur ex facta mixtione inspirati aeris cum elaborato subtili sanguine quem dexter cordis ventriculus sinistro communicet. Fit autem

from the heart, it will be allowed that he must, as a necessary consequence, have improved much upon the practice of those who held the opinion that no red blood is naturally contained in them. But it has been already mentioned, that not only was no good effect in medical practice, or in surgery, derived from the supposed discovery, but, on the contrary, medical and physiological theories have, ever since the period of Harvey, become the very scorn both of the well informed and the vulgar.

It is well observed by Galen, that no medical doctrine ought to be received, un-

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communicatio hæc non per paritem cordis medium et vulgo creditur, sed magno artificio, a dextro cordis ventriculo longo per pulmones ductu, agitur sanguis subtilis, a pulmonibus præparatur, flavus ejicitur, et a vena arteriosa, ad arteriam venosam transfunditur; deinde in ipsa arteria venosa inspirato aëre miscetur, et expiratione a fuligine repurgatur, atque ita tandem per diastolen attrahitur, apta supellex ut fiat spiritus vitalis."

less it possess three essential qualifications :
 1st, it must be true—2d, it must be useful
 —and 3d, it must be founded upon esta-
 blished principles. Πρωτον μεν αληθες ειναι
 δε.—εηα χρησιμον—εηα ακωλεσθον ταις υποκει-
 σαις αρχαις.

I have stated my reasons why I do not think the Harveian doctrine *true*—it is a matter of notoriety that it has not proved *useful*, for, as medical theory has fallen into contempt, quackery has prevailed—and I also regard it as altogether inconsistent with established principles, to suppose that there is a continual circular round of red blood, while the quantity in the human body is only sufficient to fill the veins, and right side of the heart ; or that, in a moribund animal, the whole red blood supposed to be contained in the arteries, should be forced through them, and into the veins, without pulsation, and when, according to Harvey's own doctrine, the efficient moving cause

cause is withdrawn from the heart by the collapse of the lungs.

It were no difficult task to go over, in detail, the arguments of Harvey and Wal-læus, and point out wherein they seem objectionable; but if the fact be admitted, that *there is not blood* to account for the phenomena on the Harveian hypothesis—like an *alibi* proved in our courts, it cuts off a world of circumstantial evidence, and precludes farther argument.

If then the pulse cannot be an *unda* of blood, or, as Harvey expresses it, “*impulsus sanguinis in arteriis*,” it remains to enquire what it really is, and how it is produced. Some years ago, Mr. Wilkinson of London published *Elements of Galvanism*, in which he introduced an hypothesis which, to me, appeared probable, and very ingenious, viz. :—“ That the lungs collect elemental fire from the atmosphere—that

the bronchiæ, resembling, in structure, the cells of the torpedo, possess an action somewhat similar—and that the *pulse* is literally a shock sent through the arteries.”

I thought this hypothesis probable, because the pulse is transmitted instantaneously, and not, according to the law of fluids, propelled through elastic tubes ; because pure air is known to contain elemental fire, as we inhale it, and, in expiration, is found to have lost it ; and because, in cases of increased heat of any part of the body, attended with pain, the most immediate relief is obtained by the application of cold water, or the contact of cold metals, our most perfect conductors. On this subject I wished to have the opinion of a justly celebrated experimentalist, who very obligingly and readily informed me, that “ he had always looked upon the hypothesis as gratuitous, unsupported by any one fact, and contradicted by many simple experiments. - Hydrogen gas may be breathed

for

for nearly a minute, and yet the heart beats, and the functions of life go on; and the accounts, on record, of divers, and the history of the blue boy, prove that the air cannot perform any electrical function in the lungs, for the imagined electrical shock of course would immediately cease the moment the air was withdrawn." He adds, that "he regards the muscular structure of the arteries, and the flow of blood, as sufficient proofs of the Harveian doctrine. An electrical shock could not create a wave, nor make the blood spout several feet from a divided artery." It is, no doubt, inaccurate to term any impulse that may be derived from the lungs to the arteries, or the shock of the torpedo, *electrical*, as if it closely resembled the effect produced by the friction of dry and hard substances, which we call electricity; in both cases the animal operation must be more closely allied to galvanism, for a succession of shocks (if shocks they really be) are delivered by the
lungs

lungs, when no external air is admitted, although gradually weakening, and soon to cease. That when atmospheric air is excluded, the pulse soon ceases, is certain; but, after the lungs have been once inflated, they retain a certain quantity of air, even after expiration, and few noxious gasses are so destructive of life as to extinguish it instantaneously. By practice we may accustom ourselves to hold the breath for several minutes, as divers do under water, but such suspension of respiration evidently does violence to the vital powers, and cannot be carried beyond a certain extent till it occasion the most violent symptoms. In the case of the blue boy, if the antient doctrine may be relied upon, in opposition to Harvey's, he was *blue*, because blood was protruded to the extreme arteries. For the same reason his temperature was cold; he had an obscure, feeble, and irregular pulse, and the mal-conformation of the heart, occasioning these symptoms, caused

caused his early death. Many children have the bluish tinge at birth, but if there be no mal-conformation of parts in the thorax, they acquire the natural complexion soon after respiration has begun.—For these reasons I think it probable that the pulse is the effect of elemental fire, and that the doctrine of antiquity concerning its origin and progress was well founded. “It originates,” says Erasistratus, “from the surrounding atmosphere—it is communicated to the vessels of the lungs, then to the heart, and other arteries.”* It must be needless for me to repeat, that the structure of parts, the muscular coat of arteries, and the flow of blood, afford, in my opinion, no proof whatever of the

* Γινέτο γὰρ καὶ τὸν Εῤασιστράτῳ, ἐκ τῆς περιεχούσης ἡμᾶς αἰρος, εἰσὼ τῆς σαμαλῆς εἰς μὲν τὰς καὶ πνεύμονα πρῶτης ἀρτηρίας ἐλθούσης, ἐπεὶ αὖ εἰς τὴν καρδίαν, καὶ τὰς ἄλλας.

the natural presence of blood in these vessels, or of the circulation. Upon the supposition that the artèries convey an elastic vapour, and are all of them exhalants, a muscular coat is necessary to enable them to accommodate themselves to the full hard pulse of fever, or that occasioned by violent exercise, or a contrary state, when the powers are debilitated. The steam pipes that warm our public buildings are well enough calculated to convey water, but their structure affords no proof that such is their real use. Had the flow of blood from a wounded artery afforded any proof of the circulation, that circulation must have been known from all antiquity; for arteriotomy was practised as a remedy, from the earliest times; and the effects of the wounds of arteries in battle must have been observed from the time that battles were fought, as well as from numerous accidents occurring in civil life. Neither the structure of the parts, nor the flow of blood, had
escaped

escaped the observation of the antients, but they reasoned very differently from Harvey concerning these appearances, and, in my opinion, more correctly. Whether they had particularly observed the valves of the veins does not, as far as I know, appear from their writings; but as they particularly describe the coats of both arteries and veins, I think it as improbable that they had overlooked them, as that they had never observed the lobe of the liver, called by the name of Spigelius, and said by him to have been discovered.

It is observed, I think, by Boyle, that experiments, unless wisely contrived, and carefully executed, must ever mislead; and, for upwards of two hundred years, we have had daily proofs of the accuracy of the observation. Rejecting the precepts of the schools, every individual pursued his own chosen path in philosophical research, made experiments, and drew conclusions
according

according to the extent of his own information, and strength of his reasoning faculty; and the consequence is, that we have experiments upon record to reconcile almost every contradiction. In physiology, the contradictory results of experiments and calculations are very striking. Borelli, an author much admired in his day, made the force of the heart equal to *one hundred and eighty thousand pounds*; Bernouilli corrected an error in his calculation, and reduced it to *five ounces*. Harvey supposes the whole blood of the body may circulate through the lungs and heart about twenty times in an hour, or four hundred and eighty times in a day. Blumenbach says, the whole quantity circulates through the heart several times every minute; and Richerand affirms that a thousand ounces of blood pass through the renal tissue in an hour. The Physiologists, whose opinions I think correct, in saying that coloured substances

substances will hardly pass the lacteals, because nothing passing through the alimentary canal is found to alter the sensible qualities of the blood, are opposed by others, who affirm that the bones may be coloured* by madder, carried by the lacteals into the circulation.

Amidst this confusion of opinions and contradictory assertions, without end, the phenomena of electricity and galvanism fortunately attracted the attention of men of genius, and experiments that appear fair and conclusive encourage the hope that physiology may, at no remote period,

I

rest

* There can be no doubt that coloured substances, taken into the stomach, alter the sensible qualities of many of the secretions. Rhubarb soon changes the colour of the urine, but has no effect on that of the blood. After a very large dose of nitre, blood drawn from the arm exhibits not the faintest trace of its presence, while a piece of paper, dipped in the urine voided about the same time, and dried, in burning,

rest upon a surer foundation. That there is one active principle pervading nature is now admitted, and whether called *aerial acid*, *phlogiston*, *elemental fire*, *æther*, or by any other name, it is allowed to produce whatever effect, great, marvellous, or terrible, that occurs in nature. That it is the cause of motion in animals, and things inanimate, appears probable, and to this conclusion men of science had arrived, without the aid of our recent experiments.—“With respect to the microcosm,” (says a philosophic writer of the last century,) “it is highly probable that it is phlogiston in its pure electric state, that actuates the vital frame,

shews the deflagration of the nitre, and is, in fact, converted into what is called *match paper*. Coloured substances, introduced under the cuticle, remain indelible marks, while the skin remains unchanged in its natural qualities. That the colour of the bones is changed by madder, taken into the stomach, is very true, but in what manner that change of colour is imparted, is still matter of dispute.

See Experiments by C. Darwin.

frame, and is the immediate cause of motion, the source of sensation, of irritability, and sympathy; in a word, that it is what hath been generally denominated by Physiologists, the animal spirit, or nervous fluid.

The *Platonists* and *Pythagoreans* maintained that, next to the infinite mind, and great creative power, which presides in the mundane system, the immediate mechanical or instrumental cause, that moves and actuates all its parts, is the pure element of fire. Such was the doctrine of these antient sages; nor did they widely err. From a too contracted view of the laws of nature, that diffused and active principle has been distinguished by almost as many names as energies, but we have shewn that it is the same powerful agent which we at one time contemplate in the form of concentrated light, tearing asunder the densest adamant, and, at another, rending the clouds, and threatening, with resistless destruction, the lofty oak, and the towering citadel.

“ Plato defined light to be a *rare* and *subtle* flame, $\phi\lambda\omicron\zeta \mu\alpha\nu\eta \kappa\alpha\iota \lambda\epsilon\pi\tau\eta$,* and he came nearer the truth than later philosophers have, in general, imagined. Can we desire a more convincing proof of the solid judgment and penetration of that ancient sage, than that, after the lapse of so many centuries, and the vast progress made in the science of nature, we are under the necessity of rejecting the theories of modern times, in order to revive his long exploded doctrines, as the most consonant with facts and experiments?”†

It is here evident that the learned writer means to express, by the term phlogiston, the same active principle that we call elemental fire, and that, by reasoning, he arrived at that conclusion to which our recent

* Light is related to Fire as Vapour is to Water.

† Leslie on Animal Heat.

recent experiments point, as Sir Isaac Newton did half a century before.

ARGUMENTS concerning physiological facts cannot be strictly demonstrative, but are of necessity dialectical, such as by fair induction produce belief and conviction; and I shall conclude the present imperfect sketch by briefly enumerating some of the reasons that induce me to believe the Harveyan doctrine unfounded:—

1. Harvey's first assumption, that the motion of the heart, and pulse of the arteries, is occasioned by the blood distending the left ventricle, and exciting it to contraction, is contradicted by the fact, that the heart, separated from the body, and emptied of blood, continues its motion, at first vigorously, and thereafter in a more

languid manner, till it come nearly to the temperature of the surrounding atmosphere, when it altogether ceases.

Lord Bacon mentions a case in which the heart of a criminal was exposed round the scaffold palpitating, and when thrown into the fire, leapt up the height of several feet.

2. The pulse cannot be, as he assumes, the *impulsus sanguinis in arteriis*, because it is transmitted instantaneously; whereas a fluid propelled through dilatable tubes must expend part of its force laterally, and its motion must, therefore, be progressive.

3. When a considerable artery is divided, and allowed to bleed freely, the colour of the vessel is soon changed, the blood appears venous, and pulsation is lost;—to me convincing proofs that arteries,

ries, light coloured, and pulsating, are not full of blood.*

4. The reasons assigned by Harvey for the empty state of the arteries after death, are altogether unsatisfactory; for, while he supposes the distension of the left ventricle, by blood, to be the cause of its contraction, and pulse, in the arteries, he yet assumes, that when blood is no longer furnished to the left ventricle, by the lungs, the motion of the heart still continues, and that it *expels* the blood from the arteries.—

In

* In reference to what is said, page 44, of the loss of pulsation, and change of colour, of a divided superficial artery, it is necessary to state that it is only where the vessel is of considerable size, and the blood poured out freely, that the experiment will succeed. If the vessel be small, and by its contraction pour out blood but scantily, pulsation will continue till the hemorrhage finally stop. In larger vessels the phenomena uniformly occur.

In other words, he assumes that an *effect* is, for sometime, produced without a *cause*.

5. In many cases of pulmonary consumption, before the patient dies, the lungs are almost completely exhausted, or, as Blumenbach expresses it, there is nearly a *total consumption*, when, perhaps, not one fortieth part of the substance of the healthy and perfect lungs remains. In this state of the lungs the Harveian doctrine assumes that the whole blood of the body passes through this remaining portion, many hundreds of times, within a few hours.* Yet no blood is found extravasated in the thorax,

* Blumenbach says, "The *corium*, or *cutis*, and the internal surface of the *alimentary canal*, are so intimately connected with the lungs, by sympathy, as in some degree to perform a part, and occasionally *the whole*, of *their functions*, in *their room*. This is exemplified in adults, labouring under nearly *total consumption*, or other violent affection of the lungs, and, nevertheless,

thorax, on dissection; nor are the vessels of the remaining part of the lungs enlarged.

6. After death, when the veins of the extremities have collapsed, there consequently appears a congestion of blood about the heart, as takes place when the body is exposed to cold during life, a little is found in the left ventricle, but none in the arteries.—Nor is the quantity of blood in the body sufficient to fill both arteries and veins, at the same time, according to the Harveian hypothesis.

7. The

existing, for a length of time, almost *entirely without respiration.*”

Here the circulation of the blood appears, for the time, forgotten, although, according to both Blumenbach, Richerand, and other modern Physiologists, several thousand pounds of blood should pass, during the day, from the right to the left side of the heart.

7. The ligature of the saphena occasions no considerable swelling of the foot, from which it is said to return the greater part of the blood; and the obliteration of the subclavian artery is not followed by the exhaustion of blood from the veins of the hand and arm, which, according to Harvey's doctrine, ought to take place in less than one hour after the obliteration of the artery is complete.

8. Heat, whether from violent exercise, or the application of warm air, or water, to the surface, causes a turgidity of the superficial vessels, which, according to Harvey's doctrine, arises from the encreased action of the heart driving the blood into the capillaries; but, were this really true, the *vis a tergo*, the column of blood extending from the heart to these extreme branches, ought to be found, when death occurs under such circumstances; but the arteries, as usual, are found empty.

9. The

9. The existence of valves in the veins, demonstrated by Fabricius, first suggested to Harvey, as he informed the Hon. Robert Boyle, the idea of a circulation of red blood; but the lymphatics, in which no circulation exists, are supplied with the same apparatus of valves, and, when a ligature is applied, swell, as veins do, on the side next the extremity; so that the presence of valves affords no proof of circulation, nor renders it in any degree probable.

When Harvey's doctrine was first promulgated, it was objected to Riolan, Primrose, and others, who opposed it, that they tried no experiments in order to prove his hypothesis false. To this they replied, that all his experiments, and their results, were easily to be accounted for, according to the principles of the ancient physiology—that he had drawn unwarrantable conclusions from common appearances—and that, therefore, no experiments were requisite

site to set aside his hypothesis. This was, perhaps, a sufficient answer to the objectors, when the doctrine had newly come abroad; but, after it has been for a long time generally received in the schools, it would be desirable to have some decisive experiment tried, that may, if possible, put an end to conjectures and assumptions, and finally determine the question. The following experiment, I think, will be allowed to be fair :—

In a dog of middle size, the common iliac artery, upon the Harveian hypothesis, may be supposed to carry to the lower extremity, at each pulsation, one drachm of blood, the pulsations may be eighty in a minute. Tie the common iliac vein, and allow the artery to pulsate for six minutes. Within that time, if the pulse really be an unda of blood, of the supposed quantity, the artery must throw into the limb nearly sixty ounces of blood—the vessels must be ruptured, or they must
be

be distended to the utmost, and the arteries of the limb equally turgid with the veins, the progress of the accumulated blood being stopped. If, after the lapse of six minutes, the artery be tied, and opened beneath the ligature, the quantity of blood in the limb must, I conceive, confirm Harvey's hypothesis, or entirely subvert it; for the ingenuity of the most zealous Harveian will scarcely succeed in discovering how, the iliac vein being tied, blood propelled by the iliac artery can possibly be returned into the cava.

For the above-mentioned reasons, among others, equally strong, I believe the Harveian doctrine of the circulation unfounded; for, according to the common laws of evidence, the facts are not to be reconciled to the hypothesis; nor, in my opinion, can Harvey's inferences from his experiments be born out by fair deduction, or conclusive argument. We see daily proofs how

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different.

different the judgments of men are concerning the weight of evidence, and deductions from facts, and how the public may estimate the objections I have stated to the commonly received doctrine of Harvey, I cannot tell; but the importance of the subject may excite investigation and discussion; and, if these are fairly conducted, the truth must prevail.

FINIS.

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